vascular cicatricules, the central of which is composed of two confluent dots. 4. Figure from plaster cast of an impression in the collection of Mr. McMurtrie. 4 *a*. Vertical section of one of the cushions. 5. Four cushions with their associated leaf-scars, from a specimen in the author's collection. Communicated by Mr. J. McMurtrie. The part marked *a* shows the decorticated condition. 5 *a*. Vertical section of one of the cushions.

Fig. 6. *Lepidodendron Peachii*, Kidston, n. sp. From the Brickworks, Falkirk, Stirlingshire (nat. size). Original in the collection of of Mr. C. W. Peach. 6 *a*. Leaf-scar, enlarged 2 diameters. 6 *b*. Leaf-scar, shown in profile, enlarged 2 diameters.

XXXII.—*On the Relationship of the Sponges to the Choanoflagellata.* By Franz Eilhard Schulze *.

After Dujardin, Carter, and Lieberkühn had demonstrated the agreement of certain cells of the sponge-body with *Amœbæ*, the Sponges were for a long time referred to the Protozoa. More recent investigations, however, have led to the conviction that they do not consist of colonies of homogeneous individual creatures, but of different tissues, that they reproduce sexually, and are built up out of at least two germinal layers, and consequently belong to the Metazoa.

As, however, some naturalists still continue zealously to maintain the Protozoal nature of the Sponges, it becomes necessary to test the arguments brought forward by them.

Within the last few years the opinion first put forward in the year 1866 by James Clark † has been defended with peculiar emphasis by Carter and Saville Kent—namely that the so-called *collared cells* of the sponges provided with a hyaline membranous annular frill are to be regarded, not as epithelial cells, but as *flagellate* Infusoria, and consequently the entire sponges as *colonies of Flagellata.* Somewhat as the whole of the individual animals in a colony of *Ophrydium* are placed side by side, imbedded superficially in a common gelatinous mass, so also in the Sponges the *spongozoa*, as Carter calls the collared cells, in accordance with the above-mentioned conception, are seated as independent creatures upon a common foundation after the fashion of a colony.

It is not to be denied that there exists a great similarity

* Translated from a separate impression of the paper in the 'Sitzungsberichte der Königlich-preussischen Akademie der Wissenschaften zu Berlin,' 1885, pp. 179–191.

† Proc. Bost. Soc. Nat. Hist. 1866, and Mem. Bost. Soc. Nat. Hist. 1868, vol. i.; see also Ann. & Mag. Nat. Hist. 1868, ser. 4, vol. i.

between the collared cells of the Sponges and those flagellate Infusoria, occurring sometimes singly and sometimes in colonies, which are denominated Choanoflagellata by Saville Kent and by Bütschli Calicomastiges. This resemblance is the more striking because we do not meet with similar structures elsewhere in the whole animal kingdom. In both cases we have to do with a cylindrical or rounded plasma-body with contained granules and a well-developed nucleus. From the middle of the somewhat prominent free end-surface originates a flagellum, and from the outer circular margin freely projects the so-called collar, an extremely delicate hyaline annular membrane, which generally exhibits the form of a cylindrical mantle, but is also susceptible of certain changes of form. Thus we may observe sometimes an abbreviation, sometimes a funnel-like enlargement or a contraction of the tube outwardly, sometimes a bellied inflation. Those small limpid vacuoles which regularly occur in the Choanoflagellata in the basal part, and perform rhythmical pulsations, are also asserted by some naturalists, such as James Clark, Carter, and Saville Kent, to be constant and characteristic structures of the collared cells of Sponges; but I have by no means found them regularly in the latter. Granular pigment-masses, such as occur, often abundantly, in the collared cells of *Spongelia*, *Oscarella*, and other Sponges, have hitherto not been observed in the Choanoflagellata.

Although these and other differences may appear insignificant in comparison with the remarkable agreement which is expressed in the peculiar collar, it is nevertheless clear that even so close a resemblance between certain unicellular Protozoa and individual cells of the Sponges (which consist of *three* different tissue-layers) can by no means alone lead to the conclusion that the Sponges belong to the Protozoa. The untenability of such a conclusion becomes still plainer (as, indeed, Lendenfeld * has lately pointed out) if we apply it to other groups of animals, and refer the Cnidaria, for example, to the Protozoa, because their gastro-vascular system is lined with flagellate cells, which resemble certain Flagellata.

Saville Kent † himself seems to have felt the insufficiency of such a proceeding, as he has endeavoured to bring forward, in addition to the arguments adduced by James Clark, other and indeed more cogent reasons in favour of the correctness of his conception. For this purpose he has, in the first place,

* Proc. Linn. Soc. New South Wales, vol. ix. 2, p. 329.

† "Notes on the Embryology of Sponges," in Ann. & Mag. Nat. Hist. 1878, ser. 5, vol. ii. p. 139; and 'A Manual of the Infusoria,' 1880-81.

studied the larvæ of certain Sponges, such as *Oscarella* (*Halisarca*) *lobularis*, *Grantia compressa*, *Leucosolenia botryoides*, and *Halichondria* sp., both in the developed state and during their development, and arrived at the astonishing result that these structures by no means correspond to the first developmental stages of Metazoa, but are colonies of Choanoflagellata. He infers this both from their anatomical structure and from the mode of their formation. A mature "swarm-gemmule" (as he calls the free-swimming sponge-larvæ) of *Grantia compressa*, according to Saville Kent, represents an elongate vesicle, the wall of which consists of a single layer of radially placed cylindrical cells. Each of these cells is said to bear at its outer end a marginal collar and a central flagellum, and therefore exactly to resemble the ordinary collared cells which, in a single layer, line the radial tubes of that calcareous sponge. In oviform swarm-gemmules of the same sponge which are not yet perfectly mature the long cylindrical cells are said already to possess the flagellum, but not the collar, and to meet in the middle with their diminished inner extremities. In a Calcisponge nearly approaching *Ascandra pinus*, Häck., however, Saville Kent once found an oviform larva, the broader posterior half of which consisted of collared cells projecting further from the centre. He interprets the latter as fully developed individual animals, and the flagellate cells without collars of the anterior part as not perfectly developed, and thinks that in this way he has found the clue to the comprehension of the frequently described oviform *Sycandra*-larvæ, the anterior part of which consists of simple cylindrical flagellate cells without any collar, while the hinder part is composed of broad, somewhat convex, darkly granular cells without any appendage whatever. Here the darkly granular cells of the posterior extremity are supposed to have outrun the anterior flagellate cells in their development so far that they had already retracted a previously existing collar as well as the flagellum, and were on the point of conversion into amœboid cells of the future sponge-syncytium.

It is worthy of note that, with the exception of Kent, none of all the naturalists who have paid attention to the developmental history of the Sponges, and especially of the Calcispongiæ, and have specially and thoroughly investigated the structure of the swarm-larvæ, such as O. Schmidt, Carter, Metschnikoff, Barrois, Keller, and others, has detected the collar on the cylindrical flagellate cells of the larvæ, although, according to Kent's figures, it is hardly to be overlooked; for that hyaline and more strongly refractive marginal part which Barrois has represented upon isolated flagellate cells in

fig. 29 of pl. xv. of his memoir, and which I have also detected in many swarm-larvæ, is nothing but the perfectly solid non-granular terminal part of the cells in question, from the slightly convex free surface of which the delicate flagellum originates.

In my investigations of the swarm-larvæ of *Sycandra raphanus*, which can hardly differ essentially in the structure of its larvæ from *Sycandra compressa*, and of many other sponge-larvæ, I have endeavoured, always in vain, to discover anything like the collar at the free extremity of the cylindrical flagellate cells. But when I compare the figures that Saville Kent gives of his "swarm-gemmules" with the images that one obtains by tearing up living *Sycandræ* under the microscope, I cannot avoid the supposition that what Saville Kent has described as a perfectly mature "swarm-gemmule," and finally figured in his 'Manual of the Infusoria' (pl. ix. fig. 25), is nothing more than a separated portion of the layer of collared cells, which has rolled itself up, so that the basal extremities [of the cells] are turned inwards and the collars outwards. Such deceptive images often come under observation when living *Sycandræ* are torn up in sea-water. Not unfrequently a separated sheet of cells becomes so completely rolled up, that it even appears like a closed vesicle when rotating, although, as a rule, it only forms more irregular structures, such as are figured by Saville Kent in pl. vi. fig. 17 of his memoir "On the Embryology of Sponges," in the 'Annals and Magazine of Natural History,' ser. 5, vol. ii.

Moreover, a hemispherically rolled layer of cells may occasionally attach itself to the posterior extremity of one of the oviform larvæ, which are usually present in numbers, in such a manner as to produce the form figured by Saville Kent (*loc. cit.* pl. vi. fig. 16, and 'Manual,' pl. ix. fig. 26), the posterior extremity of which appears covered with collared cells.

While, on the one hand, from my own observations, I cannot accept the composition of the bodies designated "swarm-gemmules" by Saville Kent out of collared cells equivalent to Choanoflagellata, on the other hand I must assert that, even if their structure were of the kind stated by Saville Kent, their nature, as colonies of Flagellata, would be by no means proved. They would then as now have to be regarded and described as true sponge-larvæ, because they have been produced by segmentation from a fertilized sponge-ovum, and become afterwards transformed in the same way as the well-known larvæ of other animals, such as the Hydroida, into mature Metazoa. Saville Kent will admit neither of these arguments as conclusive. He rather endeavours to

refute both of them, and to prove that the whole process which has hitherto been generally regarded as egg-segmentation, larva-formation, and metamorphosis, is nothing but an organic process of multiplication, exactly agreeing with those processes which have been recognized in various Flagellata. With this view he endeavours, in the first place, to demonstrate the agreement of the process of segmentation of the egg, observed in many Sponges, with that division of a simple Flagellate animal which leads to the formation of a considerable number of equivalent individuals, that is to say, to the formation of a colony, appealing to the descriptions given by Ehrenberg, Perty, and Schneider of the propagation of *Polytoma uvella*, by Dollinger and Drysdale of the division of a Monadine, *Heteromita uncinata*, and by Häckel of the reproductive cycle of his *Magosphæra planula*, and further adducing the results of his own observations upon the propagation of a Choanoflagellate, *Salpingœca fusiformis*, newly discovered by him. In this last organism he was able to ascertain that a typically constructed individual animal became transformed within its vase-like case, after the retraction of the collar and flagellum, in the first place into an amœba-like body. After this had passed through a resting-stage in the spherical form it underwent a regular division, the final products of which quitted the capsule as flagelliferous swarmers. From each swarmer a *Salpingœca fusiformis* was again produced.

Placing this process side by side with the egg-formation, segmentation, larval development, and metamorphosis of the Sponges, Saville Kent formed the following conception of the latter. From a simple collared cell proceeds a cell capable of amœboid movements. This, by continual binary division, undergoes a segmentation like that of *Salpingœca fusiformis*, and the final product in this, as in that case, is a considerable number of cells, which in the first place have only a flagellum, but subsequently acquire a collar, and so become collared cells, whether they constitute together a free swarm-larva (swarm-gemmule) or the collared-cell-layer of a flagellate chamber.

As an essential distinction Saville Kent then indicated only the circumstance that in the Sponges the individual animals produced by division remain united (either as a swarm-gemmule or as the lining of a chamber) and produce (in the case of the swarm-gemmule after attachment) a gelatinous basis, upon which they are then seated in a continuous layer or in groups; while the Choanoflagellata do not possess any such common gelatinous supporting substance.

But even this difference Saville Kent thought he got rid

of when he succeeded in discovering and studying the development of a Choanoflagellate form which, in the fully developed state, constitutes an adherent colony, and secretes a hyaline gelatinous substance in which all the individual animals are imbedded, partly in their typical development, and partly in various stages of development and metamorphosis.

The transformation of the individuals furnished with a flagellum and collar into irregular amœboid cells, from each of which a mass of spores is then developed by continued division, is easier to observe in this than in any other Choanoflagellate. But, according to Saville Kent's view, the spores pass through a stage furnished only with a flagellum in their transformation into the characteristic collared cells, which again, by division and the secretion of gelatinous basal substance, give origin to new colonies. Saville Kent names this newly-discovered Choanoflagellate *Protospongia Hæckelii*, and repeatedly refers to its great resemblance to the Sponges. To produce a sponge, although a very simple one, all that is necessary, he thinks, is a trifling modification in the position of the zooids, which would merely have to retreat, in the fashion of nests, into invaginations of the gelatinous "zoocytium." He further indicates that, even histologically, there is no essential difference between his *Protospongia* and a skeletonless sponge, seeing that not only do the individual animals of the Choanoflagellata resemble the collared cells of the Sponges, but even the gelatinous substance which serves as the common imbedding mass of the *Protospongia*-colony agrees with that mass of tissue which acts as the basis and supporting framework for the epithelial layer of the sponge-body.

Now it is well known that this fundamental tissue of the Sponges, in which alone the skeletal parts are developed, has been interpreted in very different ways. Described by Oscar Schmidt as *sarcode* and by Häckel as *syncytium*, it is understood by both as if its hyaline basal substance, which contains granules here and there, were produced by the fusion of the protoplasmic bodies of neighbouring cells, and itself contractile. Of these cells only the nuclei are preserved.

In opposition to this view I have demonstrated, in a series of monographs upon certain families, genera, and species of Sponges which I have been able to investigate in the living state, that we have to do here *not* with such a syncytium, but with a true *connective substance*. I have shown that in the tissue in question well-individualized, more or less distinctly limited cells with nucleus and plasma-body are to be recognized, and that these lie in a basal substance, which is

sometimes gelatinous, sometimes firm, and sometimes even of cartilaginous hardness (*corticium*). Of these cells some are freely movable, others fixed. The former can change their place by amœboid movements as "creeping cells;" while the fixed ones are sometimes irregularly stellate in form, sometimes fusiform or even filamentous, and in many cases are capable of well-marked contractions, and may sometimes even resemble smooth muscular fibres in structure and function. *The basal substance as such, however, possesses no contractility.* It is not a sarcode or amalgamated cell-protoplasm, but an intermediate substance distinct from the cell-bodies, sometimes like that of the gelatinous connective tissue. This notion of mine has lately been adopted by most spongiologists.

Saville Kent further states, with regard to the gelatinous foundation of his *Protospongia Hæckelii*, that, being at first quite structureless, it becomes converted, by the immigration of amœboid individual animals from the surface, into a tissue which exactly resembles that of the Sponges.

In opposition to this I must, however, remark, that in this case the immigration of amœboid cells does not produce a tissue such as we generally meet with in Sponges. *No fixed connective cells at all are formed.* The immigrant elements seem rather, from Kent's own showing, destined to an increase by division or for spore-formation; whilst in the Sponges, besides the amœboid wandering cells, which probably serve for the formation of the sexual products, there occur numerous other cells, which have attained special development for different purposes, partly as *connective corpuscles*, partly as *contractile fibre-cells*, partly as *gland-cells*, and partly even as *sense-* and *ganglion-cells* (as lately stated by Von Lendenfeld in the 'Zoologischer Anzeiger,' no. 186).

As a histological difference of importance we have further to note the circumstance that, as I first demonstrated, the whole surface of the connective substance of the sponge-body, which is bathed with water, so far as it is not occupied by collared cells, is covered with a single layer of flat epithelial cells, which either possess a smooth outer surface or bear each a flagellum. Such a covering of flat cells is entirely deficient in *Protospongia*.

Finally, I will also call attention to the fact that in *Protospongia* all the collared cells are immersed up to the collar in the gelatinous uniting mass, while the corresponding cells of the Sponges are only seated by their basal surfaces upon the connective foundation, but otherwise stand freely side by side.

In turning now to the criticism of the agreement of the

reproductive cycle of the Sponges and Choanoflagellata, asserted by Saville Kent, I must, in the first place, remark, that since Lieberkühn's discovery of the spermatozoa of *Spongilla*, structures have been detected in numerous sponges agreeing in their form, development, and kind of movement so completely with the spermatozoa of the higher animals, that no doubt can exist as to their true nature. Thus, even if we should not place full confidence in the statements as to the direct observation of the act of fertilization, there is the less reason to doubt of the sexual reproduction of the Sponges, as ova of typical structure, the development of which into free larvæ could in many cases be followed, have certainly been detected almost everywhere.

Saville Kent, it is true, disputes the occurrence of spermatozoa in Sponges, as, indeed, he does not admit any true sponge-ova; nevertheless it appears from his own descriptions and figures* that he has himself seen sperm-balls and their developmental stages. Only he has regarded them, together with structures of quite a different kind (such as granules of colouring-matter and cells containing reserve-nutriment), as spore-aggregates and their formative stages.

If, therefore, the Sponges possess a sexual reproduction, of which the Choanoflagellata (as probably all the Protozoa) are destitute, we find in this important difference a further confirmation of the conviction arrived at from the anatomy and histology of the two groups of animals, that the Sponges are not colonies of Flagellata, nor, indeed, Protozoa at all, but true Metazoa.

Finally, the same result is furnished by the developmental history. For different as may be the course of development in the Sponges hitherto investigated, and greatly as the accounts of individual observers may differ from each other, all the statements nevertheless agree, that *at the close of larval life two different cell-layers, an external and an internal one, may be distinguished.* In this there would be nothing to alter, even if Götte's statement (Zool. Anzeiger, nos. 183, 184) should prove to be correct, namely, that the ectoderm of the larvæ of *Spongilla fluviatilis*, which consists of flagellate cells, is entirely destroyed by exfoliation or atrophy.

If, therefore, there is no doubt as to the Metazoan nature of the Sponges, and consequently all justification of placing them among the Choanoflagellata is entirely excluded, there still remains the possibility that an affinity of the nature of *a relation of descendance* may exist between these two groups of animals whose degree of development is so different.

* 'Manual of the Infusoria,' pl. x.

In point of fact, this idea has recently found a very decided supporter in Bütschli. "As I am of opinion," says Bütschli in his remarks upon the Gastræa-theory*, "that the group of the Sponges is completely shut off from the rest of the Metazoa, *and one which originated quite independently from the section of the Choanoflagellata* (*Saville Kent*), it appears to me a mistake to take this group into consideration in the elucidation of the phylogenesis of the other Metazoa."

No doubt this opinion of Bütschli's is founded upon the same fact which has induced James-Clark, Carter, and Saville Kent to refer the Sponges to the Choanoflagellata, namely, the striking similarity of the latter to the collared cells of the Sponges. It seems natural to refer the exclusive occurrence of so peculiar a structure as the collar in two groups of animals, not to a possible double independent formation of it, but simply to inheritance; and as we have no reason to suppose that the existing Choanoflagellata are retrograde descendants of sponge-like Metazoa, but are *à priori* inclined to assume that our lowest Metazoa originated from Protozoan colonies, we are certainly easily driven to the notion that the Sponges have been developed *from colonies of Choanoflagellata*, of the possibility of the existence of which their unaltered descendants, still existing as Protozoa, furnish the clearest proof.

With such a notion, however, the assumption of a near relationship between Sponges and Cnidaria is irreconcilable. We should then have likewise to derive the latter from Choanoflagellata, for which there is not the least reason.

As is well known, it was Leuckart who first, in the year 1854 †, on the ground of the then known facts, indicated the relationship of the Sponges to the "Polypes," and in consequence referred them to his type Cœlenterata. Although this view at first met with little acceptance, Leuckart repeated it in the year 1866 ‡, and instituted a comparison between a *Grantia* (*Ascone*) and a Hydroid polype. He indicated that the simple vibratile cavity occurs in both, but that the terminal apertures of the tubes of *Grantia* represent the buccal apertures of the individual polypes; while the absence of tentacles, which are also occasionally deficient in Siphonophora and Ctenophora, can no more stand in the way of the comparison than the occurrence of the lateral incurrent orifices, which likewise occur in many Cœlenterata as so-called water-apertures; and he concluded his comparison

* Morphologisches Jahrbuch, Bd. ix. p. 424.
† Arch. für Naturg. Jahrg. 20, Bd. ii. p. 471.
‡ Arch. für Naturg. Jahrg. 32, Bd. ii.

with the remark that the histological difference between *Hydra* and *Actinia* is hardly less considerable than that between *Hydra* and *Spongia*.

These ideas of Leuckart's, which were accepted as essentially correct by Micklucho-Maclay, Häckel, and most spongiologists, have quite recently been carried further by Marshall*, who has at the same time sought to controvert the arguments which had in the meantime been brought forward by Balfour in favour of the independent origin of the Sponges from the Protozoa.

While Balfour, in his 'Comparative Embryology' (vol. ii. p. 285), had cited the peculiar character of the digestive canal-system of the Sponges, in contradistinction to the gastro-vascular apparatus of the Cœlenterata, Marshall, like Leuckart, finds precisely in the agreement of this system in the two groups a principal reason for uniting them in the same type. After appealing to his own observation of a radial arrangement of the first flagellate chambers as diverticula of the central gastral space, and to the not unfrequent occurrence of radial symmetry in mature sponges of different sections, he says in conclusion :—"The two groups are Metazoa with gastral spaces, mesenterial sacs (which in Sponges may become flagellate chambers), and canals originating from the gastral space and running centrifugally, which open outwards by means of pores, and (occasionally even in the higher Cœlenterata) serve for the reception of nourishment. These canals, like the gastral spaces (in *Reniera*), are lined with endoderm, which in both differentiates flagellate cells."

Balfour had remarked that the early development of the mesoderm in the Sponges stands in striking opposition to the deficiency of this layer in the embryos of most Cœlenterata, and called attention to the remarkable peculiarity of the sponge-larvæ.

Marshall, however, ascribes no phylogenetic significance to the early development of the mesoderm in the Sponges, referring it to "abridged inheritance," and in general recognizes no important difference between the larvæ of Sponges and Cœlenterata.

The entire absence of urticating capsules in the Sponges is explained by Marshall by their correlative connexion with the tentacles, which the Sponges have either never possessed or lost very early, while they occurred in the true Cœlen-

* Zeitschr. für wiss. Zool. Bd. xxxvii. (1882), p. 221 ; and Abhandl. der Berl. Akad. der Wiss. (1884).

terata from very early times, and led to the development of urticating capsules.

In general Marshall is inclined to conceive of the Sponges as retrograded Cœlenterata, the cœlenteric apparatus of which originally resembled that of the higher Cœlenterata, and like that possessed aquiferous pores, but at first did not employ these for the reception of nourishment. It was only later, according to Marshall's view, that a change of function took place in the Sponges, the water, and with it the food, being inhaled through the external pores. During this change any tentacles that may have existed disappeared, together with the urticating capsules, and the afferent canal-system underwent a special development.

Undoubtedly the decision in favour of one or the other of the two opposite views can only be arrived at with any degree of certainty when a thorough knowledge of the *ontogeny* of numerous Sponges and Cnidaria justifies definite conclusions as to the phylogenetic development of the two groups.

What we at present know of the ontogeny of the Sponges is *not*, to my mind, in favour of the correctness of Bütschli's hypothesis. For if the Sponges had really originated from colonies of Choanoflagellata, and been indebted to this circumstance for their collared cells, we should expect that in the ontogenetic development of the Sponges the collared cells would make their appearance in that phase which corresponds to the phylogenetic stage of a Protozoan colony, namely in the *blastula*. This would indeed really be the case if Saville Kent's representation were correct, according to which the blastula or "swarm-gemmule" (at least of *Sycandra compressa*) consists of a layer of collared cells.

But as the sponge-larvæ with which we are acquainted do not possess these collared cells, but, like the larvæ of the Cnidaria, simple *flagellate cells*, and, also like the Cnidarian larvæ, have already attained the Metazoan stage by the differentiation of two distinct cell masses before the metamorphosis into the typical sponge, and consequently the formation of the collared cells, commences, it follows that the constitution of the sponge-larvæ favours, not the independent origin of the Sponges from Choanoflagellata, but rather a close relationship of the Sponges to other Metazoa, such as the Cnidaria. It is true that in this way the agreement between the collared cells of the Sponges and the Choanoflagellata becomes more difficult to understand. But still the possibility of a spontaneous production of the collar in the

Sponges quite independently of that of the Choanoflagellata seems to me to be *à priori* by no means excluded.

The circumstance that in quite distinct groups of Protozoa we meet with delicate membranous elevations of the plasma-body, which, although not the same as, are yet similar to, the collar, may perhaps indicate that the faculty of forming such processes may be inherent in protoplasm in general, and therefore that such processes might be produced independently of each other even in different divisions of animals and at different times. I have myself observed * in *Placopus ruber*, a freshwater Rhizopod, pseudopodium-like processes, which originate on the free upper surface of the animal, and by the fusion of their contiguous lateral margins may unite to form delicate membranous funnels. The so-called undulating membranes of many ciliated Infusoria also resemble the collar in many respects; but one does not on this account assume a close relationship between those Infusoria and the Choanoflagellata.

In estimating the relationship of the Sponges to the Cnidaria the consideration of the larvæ will also be of great consequence, and certainly not less important than the comparison of the fully-developed animals, which has hitherto been principally employed. Notwithstanding the small extent of our knowledge of the two kinds of larvæ and the mode of their metamorphosis, we can even now assert that the difference between the free-swimming ciliated larvæ of the Sponges on the one hand, and of the Cnidaria on the other, is on the whole not more considerable than between the different sponge-larvæ themselves. No one can say, with regard to any ciliated larva met with accidentally in sea-water and not already known to him, whether it is a Sponge- or a Cnidarian larva. It is only after metamorphosis that those primary differences of organization by which we can easily and sharply separate the two groups from each other make their appearance.

Thus, in my judgment, we are justified in the belief that the divergence of the two lines did *not* commence before that phylogenetic developmental stage which corresponds to the ciliated larva ready for metamorphosis. But what degree of organization was attained before the separation actually took place it will be more difficult to decide.

I can find in the developmental history no satisfactory ground for Marshall's above-mentioned hypothesis, that the common ancestors of the Sponges and Cnidaria possessed

* Arch. für mikr. Anat. Bd. xi. p. 348.

radially arranged mesenterial sacs, tentacles with urticating capsules, and indifferent aquiferous pores. Although in certain Sponges at an early period radial diverticula surround a central cavity, there are also Sponges, such as the Ascones, which never develop such diverticula, and others (the Sycones) in which they only originate as sacculations of the wall. But that the Asconcs are not retrograde forms may be inferred from the circumstance that the Sycones, long before they form radial tubes, present the pure Ascon type. It is therefore very probable that the oldest Sponges possessed no radial diverticula of their central cavity, but, like *Olynthus* among the Calcispongiæ, had a simple sac-like form.

XXXIII.—*New Coleoptera recently added to the British Museum.* By Charles O. Waterhouse.

Scarabæidæ.

Scarabœus Thomsoni, Bates, *in litt.*

Supra cupreus, subtus olivaceus nitidus; tibiis nigris.
Long. 16 lin.

Somewhat bright uniform copper-colour above, very dark olive-green below. Thorax very convex, obliquely narrowed in front and posteriorly; densely asperate at the sides; the disk strongly punctured, the punctures moderately large, each with a minute puncture in the middle; the punctures on the posterior part of the disk are irregularly placed, but are generally separated from each other by about the diameter of a single puncture; the surface between the punctures shining, with a few minute punctures here and there. There is an irregular smooth median line. The sides are very regularly crenulate, somewhat angular at the middle, very gently sinuate behind the middle. Elytra distinctly narrower than the thorax, moderately convex, considerably sloping down behind the middle; the suture shining, with a few small punctures; the rest of the surface dull, especially towards the sides, densely and finely rugulose; the rugæ having a tendency to run longitudinally produces an appearance of the surface being scratched; the first interstice has a few shallow punctures; the second, third, fourth, and fifth interstices have more numerous, moderately